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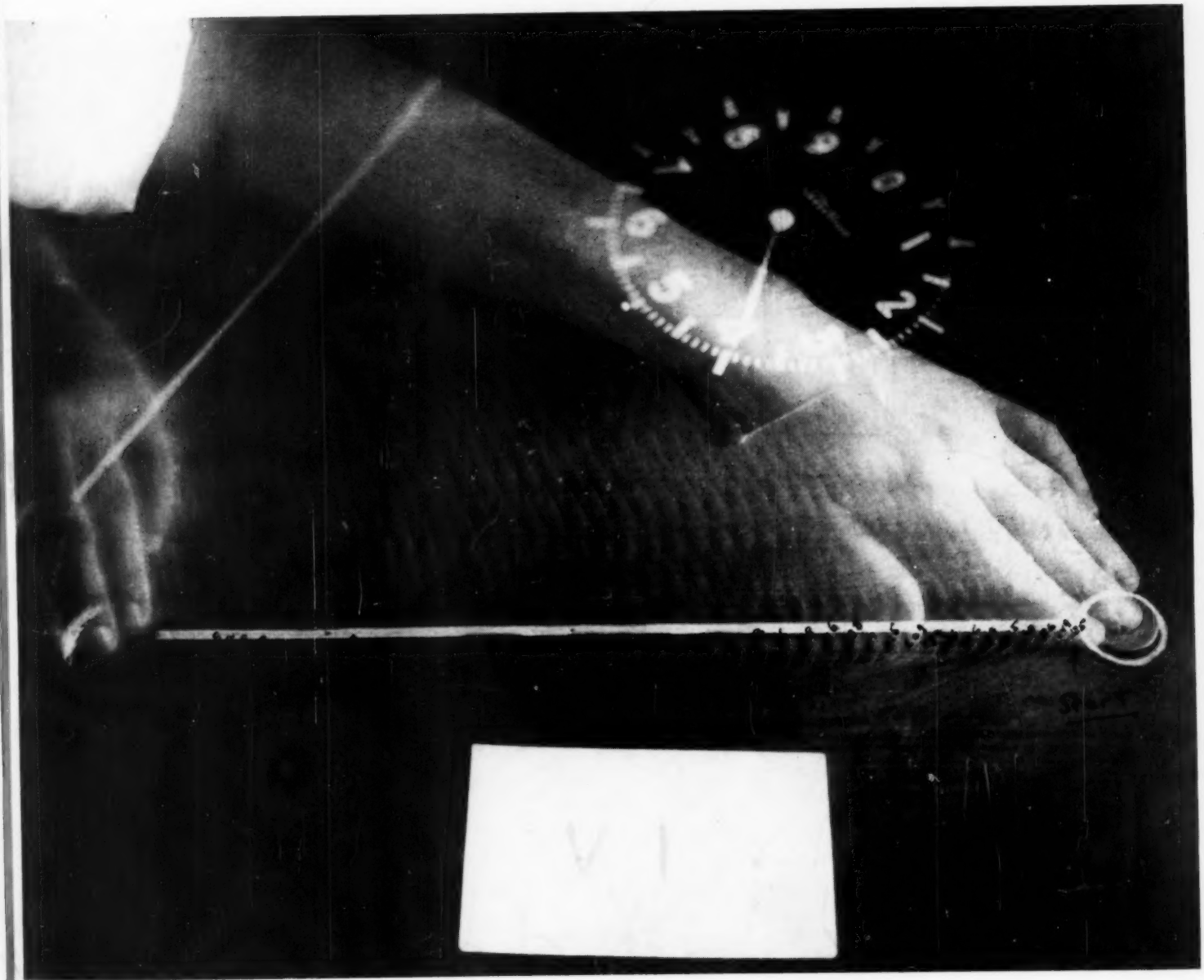

convention issue

may, 1951

AMERICAN INSTITUTE OF INDUSTRIAL ENGINEERS

REGIONS & CHAPTERS

Student Chapters ■

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2. Columbia Un.
3. Fairleigh Dickson Col.
4. Florida, Un. of
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6. Lehigh University
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H. New York City
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THE COVER

High-speed stroboscopic photograph used to investigate the characteristics of forearm motion in the Rich Laboratories of Industrial Engineering, Georgia Institute of Technology. This investigation is being performed as a Master of Science in Industrial Engineering thesis by George W. Greenwood.

Notes From The Executive Secretary

It affords great pleasure to report that our Institute has made great progress, although it has been difficult to keep the widely dispersed membership aware of what is being done.

President Allen has appointed a number of new committees, listed elsewhere in this issue. It will be noted that the first seven of these are designed to render service in the field of Industrial Engineering beyond the confines of our society, thus the American Institute enters into the second phase of its operations. When we were first organized our big task was to build a strong group of Industrial Engineers qualified to represent our branch of the engineering profession, this task will, of course, never be finished, and strong efforts will be made to continue progress in this direction.

However, with our new committees we now begin to work on projects for service to the engineering profession, industry which uses the services of Industrial Engineers, and to the public in general.

All members interested in research and writing are urged to participate. Write directly to the chairman concerned with the field of your interest or to national headquarters.

Wyllys G. Stanton

A Word From The Convention Chairman

Dear Fellow Members:

Just a note to all of you to let you know that the convention committee members have not entirely worked themselves to death — they're still kicking. Your committee has worked very hard to make this Second Annual Convention a source of professional enrichment as well as relaxation and good fellowship. The nicest way in which our members can thank us for our efforts is by attending the convention and by bringing their wives or girlfriends (don't bring both!)

One of the more serious difficulties in planning such an affair is the necessity of making definite commitments with Hotel Statler as to room size and meals contracted for. Please make our job a little easier by sending your registrations in early.

Let's all be looking forward to winding up a busy year by having a fruitful, pleasant and memorable convention! I'm looking forward to shaking hands with all of you on June 16.

K. T. Korn

SHOULD WE REPLACE THIS MACHINE?

. . . by Frank M. Gryna, Jr. INSTRUCTOR OF INDUSTRIAL ENGINEERING, NEW YORK UNIVERSITY

Mike Feeney, foreman of the turret lathe department, informs us that turret lathe #21 is wearing out and requests that it be replaced.

What facts should management consider in deciding whether or not to replace the lathe? What are the elements of a machine replacement study? Our analysis can be divided into two parts—first, a study of costs and second, a consideration of the intangibles (any relevant facts in monetary units).

Considering cost, what calculations should we make to compare the cost if the present machine is retained to the cost if a new machine is purchased? The simplest method is to compare the annual cost if we keep the present unit to the annual cost if we buy a new machine. The annual cost of a machine is composed of two parts:

1. The annual cost of recovering the investment in the machine. (We shall call this the Annual Cost of Capital Recovery or A.C.C.R.)
2. The annual operating cost consisting of labor, repairs, power, supplies, space etc.

First, then, we must calculate the Annual Cost of Capital Recovery. In doing this, we will include an interest rate (i.e. a rate of return. Why is an interest rate included in the calculations? Suppose we had to borrow the money to pay for the first cost of the proposed new machine. Here, we will agree that interest should be recognized in the calculations because we must pay interest on the borrowed money. However, even if it is not necessary to borrow the money, we should still consider interest in the calculations. If the new machine is not purchased, we have the opportunity of securing a return (interest). The dollars representing the first cost of the new machine could be invested in a safe security and eventually yield a return of 1% interest. By purchasing the new machine, we are giving up the opportunity of investing the money and earning a return. Therefore, even though the money is not borrowed, interest is a cost and should be included in the Annual Cost of Capital Recovery.

The Annual Cost of Capital Recovery can be calculated from the following formula:

A.C.C.R. = (P-L) (CRF) in + L (i)

where: P = First cost (including installation)

L = Salvage value at the end of n years

(CRF) in = Capital Recovery Factor for n years of life and i% interest

n = Capital Recovery period

i = Interest rate (in decimal form)

The Capital Recovery Factor for various values of n and i can be found on the Chart for Capital Recovery Factor.

The following example will illustrate the calculations for comparing a present machine to a proposed machine on the basis of annual cost. We are considering the replacement of turret lathe #21 and have estimated the costs of a new machine as follows:

First cost = $20,000
Expected life = 10 years
Salvage value at end of life = $5,000
Annual operating costs:
Labor = $3,000
Repairs = $150
Supplies = $50
Power = $200
Taxes, insurance, space etc. = $100

It has been decided that we could earn 6% interest if we invested the money in a security instead of buying the new machine. From the chart, the CRF for 10 years and 6% is 0.135.
Then:

A.C.C.R. = (20,000 - 5,000) (0.135) + 5,000 (0.06) = 2,325
Annual operating costs = 3,000 + 150 + 50 + 200 + 100 = 3,500

Annual Cost = 5,825

An annual cost of $5,825 will be incurred if we buy a new machine. We must compare this to the annual cost if we keep the present machine in operation.

The cost data for the existing machine is as follows:

Original cost = $12,000
Expected total life = 10 years
Salvage value at end of total life = 0
Estimated life remaining = 2 years
Present salvage value = $3,000
Annual operating costs (for the remaining life)
Labor = $3,700
Repairs = $250
Supplies = $75
Power = $250
Taxes, insurance, space etc. = $200

First, we will compute the A.C.C.R. if we keep the existing machine. For the existing machine, the Annual Cost of Capital Recovery is computed on the present salvage value and the remaining life instead of on the original cost and the original total expected life. This viewpoint is logical because interest charges are calculated only on money which becomes unavailable by the adoption of one of the alternatives. If we keep the present lathe, we forego the opportunity of collecting the present salvage value ($3,000) and investing it somewhere to secure a return. We do not give up the chance of investing the original cost ($12,000) because we cannot collect this amount today and invest it. The present salvage value is all we can realize today for investment purposes. For this reason, the A.C.C.R. for the present lathe should be based on the present salvage value and the remaining life.

From the chart, the CRF for 2 years and 6% is 0.54.

6% is 0.54. Then:

A.C.C.R. = (3,000 - 0) (0.54) + 0 (0.06) = 1,620
Annual operating costs = 3,700 + 250 + 75 + 250 + 200 = 4,475

Annual Cost = 6,095

If the existing machine is retained, the annual cost will be $6,095. With a new machine, the annual cost will be $5,825. Therefore, a saving of $270 per year will be realized if the new lathe is purchased.

The Intangible Analysis

So far, we have compared the present machine with a new machine from a cost angle only. In addition to cost, there are other elements to consider which we cannot state in monetary units. Some or all of the following elements may have an important bearing in a machine replacement study.

1. *Quality of production.* Is the quality of the finished product from the old machine comparable to that of a new machine? Often, a superior product from a new machine may be absolutely necessary to obtain a

high sales volume. In addition, a new machine may result in less spoilage — a definite cost of production.

2. *Availability of funds.* Do we have enough money available to purchase a new machine? If funds are available, we must be sure that sufficient working capital remains after the expenditure is made. If we must borrow the money, we must consider the consequences of a failure to pay back the loan.

3. *Recovery of investment.* The length of time which we allow ourselves to recover the investment in a machine is known as the capital recovery period. In some types of machines, greatly improved models are developed every few years. If we purchase a machine today and three years from now a radically improved model is introduced, competition may force us to purchase the new model. If eight years was originally allowed to recover the investment, (capital recovery period=8 years), not all of the investment in the original model would have been recovered. If an improved model is imminent, use a short capital recovery period in the calculations. In any event, try to check the possibility of an improved model in the near future.

4. *Product demand.* It is hoped that the present demand for our product will continue in the future. But suppose our competitors develop an improved product which requires different machinery. Competition may force us to buy the new equipment necessary to manufacture the improved product. Here again, we must be careful in selecting the capital recovery period. Logically, the capital recovery period should be equal to the expected life of the machine. However, if there is a chance that the product demand may soon collapse, it may be wise to use a short capital recovery period.

5. *Capacity required.* Would it be worthwhile to purchase new equipment with a greater capacity than is presently required? If a greater capacity will be needed soon in the future, it may be more economical to purchase one large machine now rather than add supplementary units in the future. Furthermore, the ability to produce large quantities in a short time may be a deciding factor in securing customers.

6. *Labor displacement.* If a new machine is purchased, will it displace any worker from their jobs If the need for a worker is eliminated by a new machine, another job must be found for the displaced worker.

7. *Machine flexibility.* Consider the existing machine and the new machine from the standpoint of doing different types of work. If the sales of product from a machine suddenly collapses, the machine must be capable of manufacturing a part which is in demand. Otherwise, we incur the cost of an idle machine.

8. *Machine breakdown.* If a machine breaks down in operation, an entire production line may be disrupted. A breakdown in an old machine may result in more time, expense and inconvenience than a breakdown in a new machine. Investigate the old and new machines to check for any difference in the effect of a breakdown.

9. *Safety.* Improved safety features on a new machine should be considered not only for worker protection but also for lower insurance charges.

10. *Work in process inventory.* Many new machines result in a saving in direct labor time. This saving can be indicated in the previous cost calculations. In addition, however, a saving in the direct labor time will result in a faster flow of product through the plant. In job shop work, the faster flow of product can help reduce the work in process inventory.

Too many companies use guesswork to decide whether or not to replace a machine. Until recently, industry has ignored any systematic approach towards machine replacement. Systematic procedures have been taught in the universities for many years. Systematic procedures are available — it's up to industry to use them.

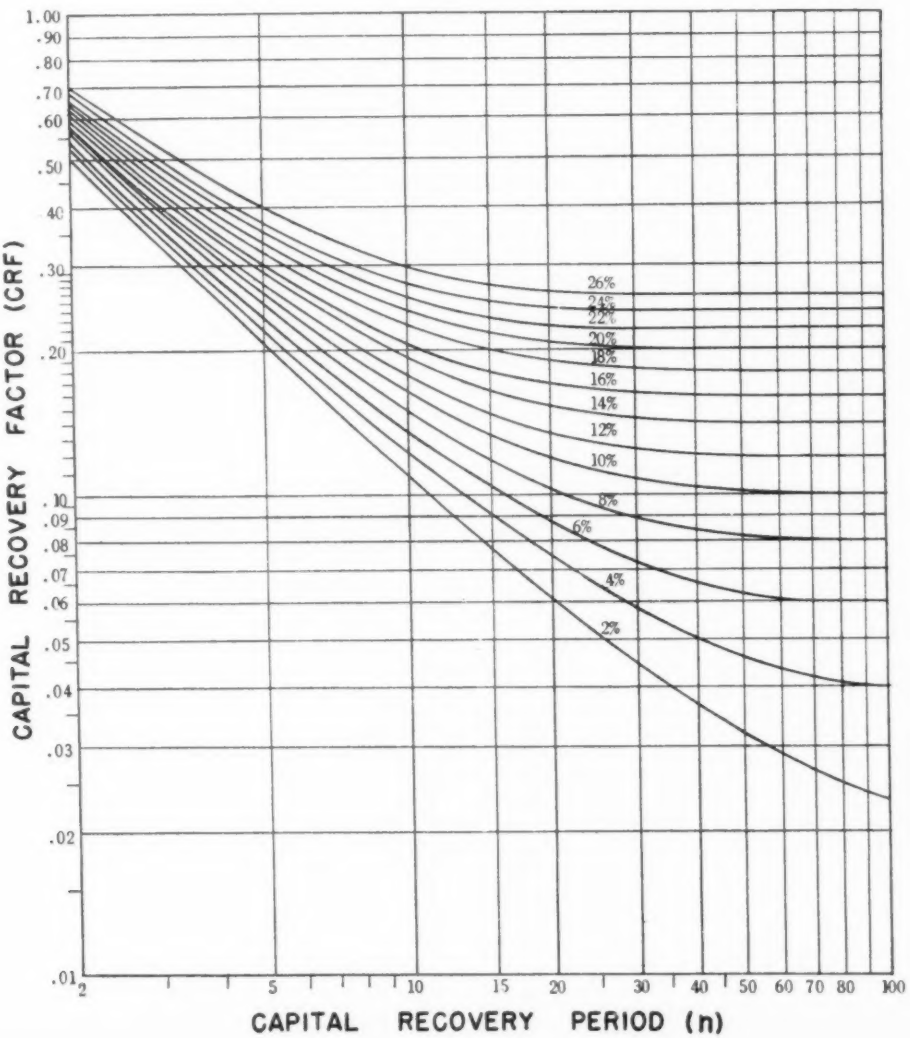

Chart for Capital Recovery Factor

"Human Engineering"

The Hallmark of Our Incentive Plan

. . . by Raymond K. Hovel

Chief Industrial Engineer, Dilts Machine Works, Division of Black-Clawson Company, Inc., Fulton, N. Y.

Mr. Hovel has engineered several wage incentive plan installations in the plants of Black-Clawson Company, Inc., the latest of which is described in this article. He has just been promoted from the position of Chief Industrial Engineer to that of Works Manager. He firmly believes, as is evidenced by this article, that "human engineering" is the master key to successful industrial engineering. This article presents a comprehensive account of the basic steps and fundamental principles involved in the installation and administration of a successful, human engineered incentive program—an actual case history showing the importance of management-labor team work.

The Dilts Machine Works — with a shop personnel of about 170 employees —is an extremely specialized plant manufacturing paper-mill converting equipment of all types. Except for a few standardized machines developed in earlier years, the company could more accurately be described as selling engineering knowledge — each customer's particular situation requiring specially built equipment. For this reason most of its productive work occurs in small quantity runs and great variety of parts — two serious obstacles to the successful application of incentives. Despite such odds and guided by a twelve year favorable incentive experience at another Black-Clawson division — Shartle Brothers Machine Company of Middletown, Ohio — the Dilts management decided in March, 1949 to try incentives. Their effectiveness has been amply proved during the past two years and has given rise to a single regret — that the decision to install an incentive plan was not made several years earlier.

The success of such a plan is not accidental. It must be purchased at the price of fair and impartial treatment of the workers, intelligent and accurate measurement of the work, and eternal vigilance against inequities of any sort brought about by careless administration. At the Dilts Machine Works incentives have resulted in a saving of 37½ per cent on all productive work, greater volume of business, better satisfied employees, greater accuracy in costs, and a greater consciousness of methods in manufacturing operations. With no limitation on incentive pay, shop-wide direct-labor premium earnings have averaged 20-22%; indirect labor 10-11%.

Preliminary Steps

Before the company's intentions were formally announced to the shop personnel, a few preliminary preparations were made by the industrial engineer engaged to carry on the project. One of these was in the form of a dual survey:

First, into the shop to observe at first hand the types of work performed, the general condition of the equipment, and the general shop practices in tooling and methods. Second, by a careful examination of the company's records to ascertain (a) the ratio of productive to non-productive personnel, (b) the activity of the company's major products, (c) the completeness and accuracy of the cost records of past performance, (d) the existing shop wage structure, and (e) the company's organizational structure and policies.

A 50-50 ratio between the productive and non-productive personnel was found to exist at the Dilts plant. This is an unfavorable ratio and it gave rise to two possible problems: the lack of participation in direct incentives of a majority group, and a top-heavy expense to be borne by measured work alone. Plans were made at once to improve the 50-50 ratio through the training and up-grading of non-productive personnel to productive jobs.

The record of activity of the companys' major products assisted the industrial engineer in determining the approximate number of time-study personnel that would probably be required to maintain adequate direct-incentive coverage.

Complete and accurate cost records of past performance were found to exist — a convenient tool in checking the incentive performance on individual operations and a reliable means for measuring the overall effectiveness of the incentive program.

The existing shop wage structure was examined in the interest of good personnel relations. The base rates were found to be consistent with the prevailing rates in comparative industries in this area. It is essential that incentive pay be used strictly as a reward for more-than-average effort, not as a loose differential to "build up" inadequate rates.

An acquaintance with the company's organizational structure and policies enabled the industrial engineer (1) to determine the proper channels through which to carry on his work and (2) to establish incentive policies consistent with the company's basic policies.

Another preparation was in the form of a series of meetings with the supervisory personnel. *This is an extremely important step in the installation of this kind of incentive program.* As number one man of the department, it is the foreman who is called upon to help "sell" the incentive philosophy to the workers, engineer manufacturing methods, instruct the workers in those methods, and help the company to obtain fair and accurate measurement of the work. With this in mind the Dilts foremen were thoroughly schooled in the mechanical details of the particular incentive system to be used and more especially in the difficulties and pitfalls sometimes encountered in such a project: resistance on the part of an employee who may have had an unpleasant incentive experience in the past; favoritism in the assignment of incentive work during the early stages of the installation; failure of the company to stand by incentive time values unless there is a definite change in method; lack of supervisory interest or attention to tooling, methods, general working conditions, or instruction of the workers with resultant unbalanced or inconsistent time values; and failure of the company to provide for incentive participation by a majority group and then to compensate proportionately those individuals who cannot practicably participate. This method of "selling" the foremen resulted in a pledge of 100% co-operation on their part to make the incentive program a success. It was further revealed to the foremen that they were to be included in indirect incentive earnings as a reward for their efforts and responsibilities in connection with incentives.

As a final preliminary step the industrial engineer prepared written description of the particular incentive system to be used at Dilts. This was for the purpose of furnishing each individual participating in the plan a simple but com-

prehensive explanation of all its essential phases: the importance and authoritative role of the foremen as methods engineer; the various methods of obtaining incentive coverage; the general categories of work included in direct and indirect incentives; the calculation of incentive earnings along with method of payment; and a few items of basic company policy, such as "no limitation on direct incentive earnings", "no cutting of a time value officially established for a given method", and "all questions concerning incentives to be brought to the attention of the foreman".

When these preliminary steps were completed an informal meeting was held with the entire shop personnel. The meeting had two important purposes:

1. to announce the company's plans for incentives
2. to introduce the industrial engineer

Pulling no punches the works manager described the company's urgent need for cost-reduction in the face of serious competition. One or two examples of attractive jobs recently "lost" served as graphic illustration of this point. He continued by expressing — on behalf of top management — the firm belief that wage incentives were one effective answer to the problem, and that a co-operative project of this sort would result not only in greater take-home pay for the employees but also in greater job security due to increased volume of business. A few words of background then served to introduce the industrial engineer who proceeded to outline the basic elements of the proposed incentive system. He was particularly careful to mention the difficulties encountered in the application of incentives to this type of highly variable work — the difficulties of coverage, methods standardization, and adequate tooling — but expressed the conviction *based on experience* that such difficulties could be largely overcome by real team work and faith. At the conclusion of a healthy, informal discussion by the group, a copy of the written description of the incentive system was given to every shop employee.

Secondary Steps

Two further steps of major importance were now taken to get the project under way.

The first was to build up a time study staff. This was done by "inviting in" three men from the shop — a skilled machinist, a foreman, and an assembler. These particular men were chosen because they possessed two important qualities:

1. a well-rounded shop knowledge
2. a reputation for honesty, fair play and good judgment

The three shop men were taught the techniques of time and motion study partly through an accelerated training course given them by the industrial engineer, partly by "on the job" training. If a wage-incentive plan is to succeed, the time study personnel must be "accepted" in the shop and must have the necessary know-how to obtain fair and accurate measurement of the work. At Dilts the fairness of the allowed time values and the complete impartiality shown the workers have enabled the time study men to "do a job" and yet be accepted as "part of the gang".

The second important step at this point was the acquisition of certain basic shop data: the machining properties of the particular grades of cast iron, steel and other materials used in the Dilts products; the capacities and limitations of the company's machine tools; tables of economical and practicable speeds and feeds; a set of standard shop practices in relation to the number of permissible cuts and amount of stock removal; and fundamental methods for general fabricating and assembly work. This information was obtained through means of experiments and tests conducted jointly by the foremen, tool department and time study department. Such data have several useful purposes:

1. As a measuring stick they enable the time study staff to evaluate work performance on a completed time study and maintain proper consistency in the time values.
2. They make possible the derivation of machine formulas and special standard data applicable to a particular line of work or set of conditions.
3. They serve as an important tool in the estimating of labor on new work for the purpose of competitive bidding.
4. They are an aid to the foreman in his important job of helping develop proper methods and then intructing the workers in the use of those methods.

Description of the Direct Plan

The Dilts incentive system is composed of two plans: the Direct and the Indirect.

The Direct Plan is one under which individual jobs are measured and individual incentive is paid to a single employee or small group. Measurement is made by time study, adaptation, and formula application. Time study alone would be far too slow and laborious in a highly specialized plant such as Dilts, but adaptation and formula application make rapid strides possible. The success of all three processes is dependent upon the consistent use of intelligent methods. And these at Dilts are principally the responsibility of the foreman. When an unfamiliar type of operation is to be covered, the operation is first analyzed by the foreman — with the assistance, if necessary, of the tooling department, general shop supervision, or time study staff. An attempt is made to determine the best conceivable method for performing the operation — the proper tooling and correct speeds, feeds and stock removal for a machining operation; the correct tooling and sequence of sub-assemblies in assembly work; and the proper holding fixtures, welding rods and weld requirements in fabrication work. *If this all-important methods engineering is not done by the company through its foremen, it will be done by the employees themselves. And that leads to loose values and inconsistencies.* After the proper method has been determined, the new operation or process is time-studied. Abnormalities are segregated as foreign elements and are adequately compensated for, along with fatigue, by a 15% allowance on *manual elements.* In addition a leveling factor is used to raise or lower the actual time spent on those manual elements to a day work pace. This factor is determined by the time study observer according to his judgment of the degree of skill and effort demonstrated by the worker during the study. The thought is constantly stressed at Dilts that good faith and co-operation during a time study pays off much better than the hold-back attitude. Examples are given to show how good skill and effort actually result in higher time allowances than does mediocre performance. An allowance of 20% or more is applied to *machine-controlled elements* after these have been properly engineered by the foreman in keeping with the basic data. Without this allowance the incentive earning possibility would be greatly reduced and the incentive program would have little chance for survival. The final step in the completion of the time study is the recording of all pertinent information on the back of the time study form. The particular form used is one developed by the Methods Engineering Council of Pittsburgh.

It the operation to be measured is similar to an operation previously analyzed and standardized in the above manner, the adaptation procedure may be used for the measurement. This involves the direct use of any directly applicable elements of the original study and the calculation by proportion or other means of any elements which are different. Adaptation, along with formula application, not only saves time but also promotes greater consistency in the allowed time values for similar operations.

Formula application is the establishment of allowed time values through the use of standard data or mathematical formulas. This has been an extremely

useful tool at Dilts in the difficult job of coverage. The formulas were developed from time studies made at the Dilts plant. In this manner they are directly applicable to the Dilts line of work and are consistent with the prevailing conditions. A few good "universal" formulas can be found in text-books, but they usually apply to standard machine tools and ideal conditions neither of which is characteristic of the typical specialized machine shop. Each formula consists principally of two parts:

1. A group of constant time values which remain the same for similar types of manual work performed under similar conditions.
2. A group of variable time values which change with each new set of conditions.

The formula may be used "at the desk" or "on the spot" depending upon the complexity of the operation. No formula is accepted for general use until it has been thoroughly tested on a variety of operations and found to provide fair and accurate time values. ,

Through the use of the three methods of coverage above described, the Dilts time study staff has maintained from 70 to 85 per cent incentive coverage on the operations of five departments: machine shop, assembly department, welding shop, bar and heat-treating department, and carpenter shop. An average of 700 operational time values are established per month on a broad variety of work.

Some of the Problems

The Dilts Direct Incentive Plan has not been entirely free from an occasional difficulty or problem. Occasionally a loose time value "creeps in" due to inadequate methods engineering. To date such situations have been corrected, first, by pointing out to the employees affected the unfairness of such values to the other employees, and, second, by getting their consent to have the operation restudied. The company's own good faith in "standing behind" properly established time values is unquestionably the reason for this sportsmanlike attitude. Any question that arises concerning a time value, an error in incentive pay, or any other phase of the program is handled by the foreman. He personally obtains a satisfactory explanation or correction of the situation and conveys the necessary message to the employee involved. In this manner the foreman has remained number one man of his department at Dilts and is respected as such by his workers. Carless work is subjected to a mild but effective penalty — the loss of premium earnings on the parts involved. Contrary to the oft-made assertion that incentives produce high scrap records, the amount of time involved at Dilts in bad work and its correction or replacement has rarely exceeded 3% of the total direct labor hours spent during any given week — a further indication of the fairness of the time values. During its first two years of existence the Dilts incentive program has had not a single major complaint.

Direct premium pay is computed and paid weekly as a part of the employee's weekly earnings. Due to the simplicity of this particular incentive system — a variation of the standard-hour plan — an employee can keep an accurate daily record of his premium earnings.

The Indirect Plan

In order to make incentive participation available to all shop employees, Dilts inaugurated the Indirect Plan within five months after the begining of the Direct. The Indirect Plan applies to work which is not measurable on a direct basis. Some of the jobs included in this category are: tool-making, tool-grinding, maintenance, stock handling, crane operating, crane following, shipping, sweeping, and yard work. At Dilts indirect incentives have shown their effectiveness in terms of increased interest and co-operation on the part of the indirect employees. Indirect premium pay, computed once a month, was arbitrarily set at one-half the average direct premium percentage earned on all direct premium work during the month. It is thus of advantage to the non-productive workers to help raise the percentage of direct premium earnings.. The Indirect Plan is also extended to the shop supervisory group and to the portion of measurable work not yet covered. It is felt that this fair treatment has amply paid off in the good will that prevails at this company.

Some of the Benefits

Two major benefits had been predicted for the employees — greater take-home pay and greater job security due to increased volume of business. The company proved right on both counts. The Dilts employee's earnings are high among comparative industries, and the company's strengthened competitive position has helped it to obtain certain jobs that would otherwise have been "lost". Accurate cost comparisons made during the first year of incentive operation revealed a saving of 37½ per cent on all direct labor. This means that a year and a half of productive work was shrunk into one year, with a parallel saving of a portion of the non-productive labor. To date the records indicate a saving of approximately 90,000 man-hours of labor. In addition, the company's costs are much more uniform, delivery schedules are being met, and foremen and operators alike have become methods-conscious. Finally, the employees and supervisors alike, look up to and respect *their* incentive plan.

Alpha Pi Mu

THE NATIONAL INDUSTRIAL ENGINEERING HONOR FRATERNITY

. . . by Jay Klein

Alpha Pi Mu, the national industrial engineering honor fraternity, confers membership upon those students who have shown exceptional academic interests and abilities in the field of industrial engineering. The fraternity was founded at Georgia Tech., January 25, 1949, and has had a remarkable growth, until it now has chapters at Ohio State, The University of Alabama, Virginia Polytech, New York University, Washington University, Oklahoma A and M, and Columbia. Many other colleges and universities have applied for charters, and indications are that this growth will continue until there are chapters of the fraternity at the majority of schools offering courses in industrial engineering.

Until recently, there was little need of an honor fraternity of this type; the industrial engineering profession was comparatively new, and few schools offered a degree in this field. Now, however, industrial engineering has found its place in the engineering profession, and a formal training is more necessary now, than formerly, to met industry's demand for well schooled engineers of high leadership ability. The adoption of a standard curricula called for an agency to recognize superior performance and confer commensurate honor. Accordingly, Alpha Pi Mu was founded to further the interests of industrial engineering, to create a closer student faculty relationship by bringing together the needs and thoughts of both and to confer recognition upon the student of industrial engineering who has shown exceptional interest and ability in his field.

The badge of the organization is a gold key, which consists of a triangle superimposed upon a cog wheel. On each leg of the triangle is one of the letters Alpha, Pi or Mu. The undergraduate or alumni who wears this key has shown excellence of scholarship, leadership, character, ethicality and sociability as well as breadth of interest. Membership is not confined to the student alone, however, for the charter makes provision for honorary initiation of those men who have made outstanding contributions to the field of industrial engineering.

Second Annual Convention

The Cleveland Chapter has been selected as host of the Second Annual Convention of the American Institute of Industrial Engineers, Incorporated. The convention will be held at the Hotel Statler, Saturday, June 16, 1951, in the Ohio Room on the mezzanine.

The following program has been planned for the convention. Please note that Cleveland is on Eastern Daylight Saving Time.

PROGRAM

For

SECOND ANNUAL CONVENTION

Morning

8:30-9:30 Registration
9:30 Chairman's recognition of Chapters
10:00 Developments on Industrial Engineering
12:00 Luncheon
Speaker — Ewan Clague, Commissioner, Bureau of Labor Statistics, U. S. Department of Labor, Washington, D. C.
Subject — "Productivity, Here and Abroad"

Afternoon

2:00 Business Session
Agenda
Read minutes, last convention
Old business
Treasurer's report
Standing Committee's Reports
President's Report
Tellers' Report on Election
Installation of officers
New Business
Adjournment
4:00 Committee Meetings
6:30 Banquet, Fellowship awards, music and dancing

A program is being planned for the ladies for the afternoon. Ladies will join the meeting at 6:30.

THE COMMITTEE

General Chairman —
K. T. Korn — *Edward A. Berk & Associates*
Vice Chairman —
J. F. Shuri — *Ohio Rubber Company*
Program —
M. C. Miller — *Republic Steel*
Louis Ufholz—*American Greeting Publishers, Inc.*
Technical Papers —
L. R. Grimes — *Ohio Rubber Company*
Publicity —
Joseph Terr — *Consulting Engineer*
Registration —
George J. Fisher — *Republic Steel Corporation*
Ladies' Program —
Mrs. K. T. Korn

THE SPEAKER

We were fortunate in securing Commissioner Ewan Clague, head of the Bureau of Labor Statistics. Commissioner Clague is a well-known public speaker and also thoroughly familiar with the timely subject on which he will talk. Under his direction, his bureau has conducted very extensive studies on productivity in this country and particularly in the Western European countries. The studies have been in progress since 1946 and will form much of the factual and statistical foundation of Commissioner Clague's discussion.

THE LADIES' PROGRAM

The national executive board and your convention committee were unanimous in their desire to have at least part of the convention with our ladies. All too often we let our technical and professional interests dominate the AIIE meetings and events and it is our belief that at least once a year we would like to drop the serious aspects of industrial engineering and make room for good fellowship, and some relaxation. We have therefore asked Gladys Korn to plan a program for the ladies for the afternoon, so that our wives and girlfriends will not be bored or forgotten. They will join us around 5:30 about which time we expect to adjourn our closed session.

THE ENTERTAINMENT

Starting at 6:30 we shall have music. Arrangements are being made by Clint Noble, famous entertainer and entertainment director.

THE COST

To defray the expenses of the convention a registration fee of twelve dollars ($12) will be charged to members. The fee will include all expenses inclusive of luncheon and banquet. For the ladies there will be a charge of five dollars ($5) to cover expenses of the banquet.

REGISTRATIONS

You are requested to register early. Registrations should be mailed in advance to:

GEORGE J. FISHER
369 Station D, 5610 Hamlet Avenue,
Cleveland, 27, Ohio

Please inclose your check for $12 for the men and $5 for the ladies.

HOTEL ROOMS

The Statler Hotel has set aside a block of rooms to accommodate out of town members. Please make your reservations directly with the hotel by writing to:

MR. J. L. WATSON, Front Office Manager
Hotel Statler, Cleveland, Ohio

stating type of accommodation desired, date and approximate time of arrival and checkout. Please state that you are an AIIE member to insure proper accommodations and handling.

CONSTITUTION – AMERICAN INSUTI

ARTICLE I — NAME

Section 1 — The name of this organization shall be the American Institute of Industrial Engineers, Hereinafter called the AIIE.

Section 2 — Each local Unit of the AIIE shall be known as a chapter and shall be called by the name of the city or county in which it is located followed by the words "Chapter of AIIE".

Section 3 — Where chapters of the AIIE are non-existent, each member shall be known as a member of the AIIE and shall be afforded the same rights and privileges as any other person belonging to the organization.

ARTICLE II — PURPOSE

The purpose of this Organization shall be:

1. To maintain the practice of industrial engineering on a professional status.
2. To foster a high degree of integrity among the members of the industrial engineering profession.
3. To encourage and assist education and research in areas of interest to the industrial engineer.
4. To promote the interchange of ideas and information among members of the industrial engineering profession.
5. To serve in the public interest by the identification of men qualified to practice as industrial engineers.

ARTICLE III — CODE OF ETHICS

The code of ethics of the AIIE shall be the Canons of Ethics of the National Society of Professional Engineers.

ARTICLE IV — MEMBERSHIP

Section 1 — There shall be four classes of membership:

A — Student
B — Junior
C — Active
D — Fellow

Only fellows, active, and junior members shall be entitled to vote and hold office.

Section 2 — A. Student members shall be regularly enrolled students of accredited curricula in industrial engineering. Student members may transfer to junior membership upon graduation.

B. Junior members shall be engineers-in-training engaged in industrial engineering work or graduates of engineering curricula accredited by the ECPD and engaged in industrial engineering practice. Junior members may transfer to active membership upon receipt of their professional license or upon the attainment of five years of professional industrial engineering experience.

C. Active members shall be state licensed professional engineers engaged in industrial engineering practice or other persons who can present proof of long experience in industrial engineering practice.

D. Fellows shall consist of a small group of outstanding leaders in the profession, who are to be honored by being elected to this grade of membership. Fellows must have given at least 15 years of service to the industrial engineering profession and shall be selected by the executive council and approved by the National Convention. Not more than five percent of the total membership is to be admitted to this group during any one year, the total number never to exceed ten percent of the membership. The start of this group is left to the discretion of the Board of Trustees.

Section 3 — Any member may withdraw from the AIIE any time by sending a formal statement to that effect to the executive secretary. In event of withdrawal any refund of unexpended dues will be waived.

Section 4 — Any member neglecting to renew his membership by the payment of dues is to be carried on the rolls for an additional 45 days, during which time he is to receive a notification from the executive secretary that his membership has lapsed. If his dues have not been received at the end of this period the member's name shall be dropped from the rolls. Any member so dropped can rejoin the AIIE by sending in a new application.

ARTICLE V — ELECTION OF MEMBERS

Section 1 — Persons who wish to join the AIIE and who feel that they have the required qualifications shall apply by filing an authorized application blank, obtainable from the national office, with the executive secretary.

Section 2 — After reviewing the applicant's qualifications, the membership committee will confer or withhold membership in the AIIE subject to the approval of the Board of Trustees. The membership committee shall consist of three members appointed by the president with the approval of the Board of Trustees.

ARTICLE VI — CHAPTERS

Section 1 — There shall be two classes of chapters, namely active and student.

Section 2 — Active chapters shall consist of ten or more regular members (fellows, active, or junior) of the AIIE who have been granted a charter upon application to the Board of Trustees.

Section 3 — Student chapters shall consist of ten or more student members of the AIIE who have been granted a charter upon application to the Board of Trustees.

Section 4 — Each student chapter at the beginning of each school year, shall appoint an advisor from the faculty of their university. This advisor, who shall be known as the honorary chairman, shall be a regular member of the AIIE. No advisor shall serve for more than two consecutive years.

ARTICLE VII — ORGANIZATION

Section 1 — The National organization of the AIIE shall consist of an association of all the members, divided into regions, as specified by the execu-

tive committee.

Section 2 — The legislative body of the AIIE shall be the national convention and shall consist of the national officers, delegates from the various active chapters, and one delegate-at-large from each region for every 100 members or fraction thereof. The delegate-at-large, who will represent the members who are not affiliated with chapters, shall be appointed by the vice-president of the region no less than 30 days before the meeting of the national convention. Each chapter shall be entitled to send one voting delegate. The national convention shall meet every year at such time and place as shall have been determined by the Board of Trustees.

Section 3 — The national officers of the AIIE shall be as follows: President, Executive Secretary, Assistant Executive Secretary; Treasurer, two board members-at-large, and one vice-president from each region who shall serve as deputy of that region. *These officers shall constitute the board of Trustees of the AIIE.* All officers except the Board members-at-large shall have terms of office of one year. The board member-at-large shall serve two years. The officers shall carry such duties as are customarily connected with their offices and such additional duties as may be assigned to them by the national convention.

Section 4 — A slate of officers, excluding the vice-president, for the AIIE shall be drawn up yearly by a nominating committee consisting of the vice-presidents. At least two and not more than three names shall be put up for each office.

fice. Officers shall be elected by a mail vote of the entire regular membership, the ballots being distributed and counted by the executive secretary. Until such time as there are at least three vice-presidents, the board of trustees shall constitute the nominating committee.

Section 5 — The vice-president for each region shall be elected at the same time as the remaining national officers by the entire regular membership of the region in which he is to serve. At least two and not more than three names for this office shall be drawn up by a nominating committee consisting of the chapter chairmen and the delegate-at-large from the region. The nominating committee will count the ballots. The retiring vice-president will be responsible for the preparation and execution of the election.

Section 6 — *The president, executive secretary, assistant executive secretary, treasurer, and retiring president shall constitute the executive committee,* and shall have the duties and powers delegated to it by the Board of Trustees.

Section 7 — Vacancies in the Board of Trustees which may occur in the interim between elections shall be filled by that board. Members so elected shall serve until the next election when the remainder of the term shall be filled by action of the regular membership.

Section 8 — The Board of Trustees shall exercise powers of the National Convention in the interim between conventions subject to such restrictions as may be imposed by any convention and to the provisions of this constitution.

Section 9 — The organization, time of meetings, committees, etc. of the Board of Trustees and the Executive committee shall be left to the discretion of these two bodies respectively, provided that nothing in this section is construed as conflicting with any other section of this constitution.

Section 10 — The vice-presidents shall supervise the chapters in their respective regions and shall arrange for regional conferences as stated in the by-laws.

Section 11 — The assistant executive secretary shall assist the executive secretary and have additional duties as may be delegated to him by the Board of Trustees.

Section 12 — A quorum for the National Convention shall consist of those present. A quorum for the Board of Trustees shall consist of two-thirds of its membership.

Section 13 — The executive secretary, at the close of each fiscal year, shall draw up a budget for the coming year to be presented to the Board of Trustees for approval.

Section 14 — Any necessary action pertinent to the proper functioning of the financial status of the AIIE shall be taken by the Board of Trustees.

Section 15 — The National Convention, upon recommendation of the Board of Trustees, may provide for financial compensation to any officers or employees of the AIIE.

ARTICLE VIII — LOCAL POWERS

Section 1 — Each chapter shall have complete control of all matters of local concern under such restrictions as may be imposed by this constitution, the by-laws, or the national convention. In no case shall such powers be exercised contrary to the ideals and purpose of the AIIE.

Section 2 — Each chapter shall be required to submit to the Board of Trustees for its approval its constitution, by-laws, and any amendments which may be enacted from time to time.

Section 3 — The officers of each chapter shall be the chairman, vice-chairman, secretary, and treasurer. When desired, the two latter officers may be combined. All officers of the chapter shall be elected at some convenient time subject to the provisions of the chapter's constitution and by-laws.

ARTICLE IX — SUSPENSION AND EXCLUSION

Section 1 — Any member convicted by the chapter to which he belongs of conduct unbecoming to a gentleman and to a member of his profession shall be dismissed and deprived of his membership. The justified withdrawal of an engineer's state license might be construed as a case to apply in this article. Such exclusion requires

a three-fourth vote of all of the members of the chapter in which the proceedings were initiated and shall be reviewed by the Board of Trustees before it becomes effective.

Section 2 — The Board of Trustees may expel for cause, any unaffiliated member of the AIIE, provided this member is given the opportunity to answer the charges pending against him before final action is taken.

Section 3 — The National Convention shall have the power, by a three-fourth vote, to withdraw or suspend the charter of any chapter for cause upon the recommendation of the Board of Trustees, provided that the delinquent chapter shall have been given due notice that such action will be recommended. This notice shall be accompanied by a statement of the charges pending against the chapter and the chapter shall be given the opportunity to reply to these charges before final action by the convention.

ARTICLE X — SPECIAL CONCESSIONS

Section 1 — The Board of Trustees, upon careful consideration and by unanimous consent of all board members, may grant a chapter exemption on from rules and regulations passed for the AIIE as a whole for a limited time. This grant shall be revoked when the existing conditions no longer warrant this consideration.

Section 2 — The Board of Trustees shall be empowered to call special meetings of the National Convention whenever existing conditions warrant such an action.

ARTICLE XI — BY-LAWS

The Board of Trustees, by a three-fourth affirmative vote, shall have the power to pass, repeal, or modify any by-laws pertaining to matters not expressly specified in this constitution.

ARTICLE XII — AMENDMENTS

Section 1 — Amendments to this constitution may be proposed by any one regular member of the AIIE or by the Executive Council.

Section 2 — Any amendment shall require for its passage a three-fourth affirmative vote of the National Convention.

Section 3 — A copy of the proposed amendment shall be sent to each regular member by the executive secretary at least sixty days before the National Convention.

Section 4 — If desired, a mail vote on a proposed amendment may be taken by the executive secretary. In this case, ballots shall not be counted for sixty days after the mailing, date, and the affirmative vote of a majority of the entire regular membership shall be required to amend this constitution.

ARTICLE XIII — EFFECTIVE DATE

Section 1 — This constitution shall become effective upon ratification by a simple majority of the charter membership.

Section 2 — A charter member shall be defined as a member on the rolls of the AIIE at the time the constitution is mailed for the vote.

BY-LAWS

ARTICLE I — AWARDS

A distinguished service award of appropriate design may be awarded to any member of the AIIE who, in the eyes of the National Convention that makes the award has rendered some outstanding service to his profession. No more than one award shall be made at any one convention. Nominations for this award must be submitted to the executive secretary either by chapters or by regular members at least five months before the date of the Convention. The executive secretary will present the nominations to the Board of Trustees which will make a recommendation to the National Convention.

ARTICLE II — COMMITTEES

Standing committees of the AIIE shall be: Executive and Membership, as defined in the Constitution, Professional practices, and education. All standing committees except the executive committee, and all other committees shall be appointed by the president and shall perform such duties as may be assigned by him.

ARTICLE III — SPECIAL DUTIES

Each vice-president shall check the activities of the chapters in his region and present an annual report to the Executive secretary. In addition, he shall arrange for a regional conference and he shall encourage a large turn-out of the unaffiliated membership. He shall present a brief, written report on his region to the National Convention.

ARTICLE IV — BOARD OF TRUSTEES

Section 1 — Any regular member of the AIIE is eligible to become a member of the Board.

Section 2 — The Board shall hold at least one meeting a year, the expense of such a meeting being paid from the funds of the National Treasury.

Section 3 — The Board of Trustees shall be the administrative body of the AIIE and may delegate duties to the executive committee.

Section 4 — The National President shall prepare a detailed report to be presented to the National Convention every year.

Section 5 — The Board of Trustees shall have such powers as are necessary to the proper functioning of the AIIE, provided that nothing in this section shall be construed as contrary to the constitution, by-laws, and ideals of the organization.

ARTICLE V — FINANCE

Section 1 — The fiscal year shall be the calendar year.

Section 2 — The dues shall be as follows: student members, one dollar; junior members, two and one-half dollars; and active members, five dollars per year. The initiation fee for all regular members shall be two dollars with the exception of student members who, upon graduation, may transfer to junior membership by paying student dues for one additional year.

ARTICLE VI — MISCELLANEOUS

Section 1 — Robert's Parliamentary rules of order shall be the standard authority for all business transacted.

Section 2 — Reports shall be made by every officer of the AIIE whether National or local, whenever required to do so by the Board of Trustees. Each chapter chairman shall prepare a report for presentation to the National Convention.

Section 3 — The expenses of the Board of Trustees shall be paid from the treasury as directed by that Board.

ARTICLE VII — AMENDMENTS

These by-laws may be amended at any time by a three-fourth affirmative vote of the Board of Trustees. Any amendments adopted shall not become effective for a period of thirty days.

Respectfully submitted,
Constitution Committee
Walter H. Friedlander, Chm.
Joseph Myers
Thomas Kenan

Finances Of The Institute

Because of pressure of other engagements the firm of Certified Public Accountants who audited the records for the year ending March 31, 1950, has not yet been available. Nevertheless it has been decided to publish the statement prepared by our own accountant. Last year no changes were made by the independent auditor.

All money received is deposited in the Huntington National Bank of Columbus. Disbursements are made only on cheques signed by the treasurer, or in emergencies by the Executive Secretary. Both men are under fidelity bonds payable to the A.I.I.E. It will be noted that records are kept on a strictly cash basis and furniture, fixtures and office machinery worth $450.00 is not shown. No officer receives any compensation.

American Institute of Industrial Engineers
FINANCIAL REPORT

Receipts and Disbursements

RECEIPTS:	12 mos. ending March 31, 1951	3 mos. ending March 31, 1951
Initiation Fees	$ 194.00	$ 52.00
Junior Dues	549.65	330.65
Senior Dues	1,002.50	437.50
Student Dues	1,363.60	316.60
Pins	223.00	66.75
Certificates	5.00	
Miscellaneous	277.32	9.98
TOTAL	$3,615.07	$1,213.48
DISBURSEMENTS:		
Telephone	$ 42.46	$ 7.96
Supplies	455.97	127.45
Rent of Office	200.00	75.00
Clerical salaries	1,461.00	244.20
Postage	250.86	90.09
Refunds, rejected applic.	40.00	12.50
Pins	157.49	70.55
Printing (incl. Journal)	742.54	
Miscellaneous	232.55	26.71
TOTAL	$3,582.87	$ 654.46

Position

Cash in bank, subject to cheque	$1,537.83
Cash in office petty cash fund	3.42
TOTAL	$1,541.25
Less accounts payable 3/31/51	107.10
Cash available for operations	$1,434.15

National Committee Organization

President Robert E. Allen has appointed eleven national committee chairmen and some of the personnel of a number of them. Other members who are interested in any particular committee work are requested to notify National Headquarters. The committees and present personnel are as follows:

1. *On Synthetic Time Systems*

   Chairman Mr. K. T. Korn, 610 Nat'l. City Bank Bldg., Cleveland 14, Ohio; Mr. Herbert K. Dowler, 511 Thayer Ave., Ashtabula, Ohio; Mr. L. M. Ufholz, Am. Greeting Publishers, 1300 West 78th St., Cleveland 2, Ohio.

2. *On Industrial Safety & Accident Prevention*
   Chairman Mr. Jack Mims, 1327 Wood St., Dallas, Texas; Mr. Hugh Monroe, Dist. Safety Engr., Abilene Dist., Texas Employers' Insurance Ass'n., Dallas, Texas; Mr. George D. McCeney, 300 Insurance Bldg., National Surety Corp., Richmond, Va.

3. *On Statistical Quality Control*
   Chairman Mr. Joseph Movshin, Wagner Electric Corp., 6400 Plymouth Avenue, St. Louis, Mo.

4. *On Production Control Systems*
   Chairman Prof. C. B. Foos, School of Industrial Engr., Georgia Inst. of Technology, Atlanta, Ga.; Mr. G. T. Mitchell, 19 Dover Rd., Long Meadow, Mass.; Mr. Norman V. Gomes, 716 West State St., Trenton 8, N. J.

5. *On Materials Handling & Handling Costs*
   Chairman Lt. Col. John D. Day, School of Industrial Engr., Georgia Institute of Technology, Atlanta, Ga.; Mr. Dominic C. Giovinazzo, 663 West Highland, Ravenna, Ohio.

6. *On Industrial Engineering Terminology*
   Chairman, Mr. Richard J. Bess, 1415 East Washington, South Bend, Ind.

7. *On Application of Industrial Engr. Techniques to New and Unusual Fields*
   Chairman not yet appointed.

8. *On Membership*
   Chairman, Mr. Jas E. Shondell, 2531 No. 4th St., Columbus, Ohio.

9. *On Registration*
   Chairman, Mr. Jos. C. Nichels, 3245 Lubbock St., Ft. Worth, Tex.

10. *On Chapter Organization*
    Chairman, Mr. Paul R. Grady, Portsmouth, Ohio.

11. *On Public Relations*
    Chairman, Mr. Sam D. Lockskin, 490 Crescent Rd., Mansfield, Ohio.

It is expected that the committees will work toward standardization of Industrial Engineering practice in their respective fields. The program will take long; not to complete, for the work will never be completed, but to make significant progress. No doubt interim reports and monographs will be published.

Dues Increased

All members are reminded, as reported in the last issue of the News Letter, the By-Law covering dues was changed, effective May 1, 1951. The current rates are as follows:

Student Dues	$2.00 per year
Junior Dues	5.00 per year
Senior Dues	10.00 per year

The initiation fee still remains at $2.00. All members pay dues only for the actual time they belong as Student dues are pro-rated if collected after Dec. 31st so that all student memberships expire on Sept. 30th. Junior and Senior dues are either pro-rated (certain chapters collect their national dues) or mature on the anniversary date of the membership.

Readers who have examined the financial statement elsewhere in this issue will observe that during the last fiscal year receipts exceeded expenditures by only $32.20. At the same time a number of projects which members have requested have been delayed due to lack of funds.

In addition to these reasons is the fact that rising costs of all goods and services required to operate the Institute made it imperative for the Board of Trustees to obtain more income. Many members recognized this problem and suggested that AIIE dues were too low in relation to its objectives and to the charges of other technical professional societies.

WHAT IS STATISTICAL QUALITY CONTROL?

. . . by Ralph A. Hefner

DEAN, DIVISION OF GENERAL STUDIES, GEORGIA TECH

Most articles on statistical quality control are written to instruct the potential user in the techniques and mathematics of the subject. Dr. Hefner's discussion, however, deliberately departs from this approach and devotes itself to a simple, highly informative description of the basic principles, the reasons for their use, and the advantages thereof.

Many industries, both large and small, are already thorougly acquainted with statistical quality control. Having used it in their plants for several years, they have verified for themselves the startling results that can be obtained by applying statistical principles to the control of the quality of their products.

Other industries, however, have heard only vaguely that a new technique has been developed for the control of product quality. These are the industries that are now asking the question, "What is statistical quality control"?

When a person asks this question, he is, in most instances, asking to be told what statistics has to do with the control of quality. It does not occur to him that his ideas of "quality control" may also need clarification, yet it often happens that the use of statistics in the control of quality is difficult to understand simply because no clear agreement has been reached as to what is meant by "quality control" itself.

One cannot thoroughly understand statistical quality control until an agreement is reached as to what is meant by "quality", then, what is meant by the "control of quality."

What Is Quality?

What does the word "quality" mean when applied to a manufactured article? It requires only a moment's reflection to realize that when one speaks of quality, one may be speaking of a great many different attributes. A characteristic that would be regarded as of vital importance in one manufactured article may be a trivial characteristic in another.

In the manufacture of a crank shaft for an internal combustion engine, certainly, the diameter of the shaft is of vital importance. On the other hand, in the manufacture of an aspirin tablet, the exact diameter of the tablet is immaterial, but the weight of the tablet is of prime importance.

So it is with every manufactured article. There are always one or more characteristics that are of vital importance if the article is to be judged of good quality. This importance characteristic—whether it be the length of a valve stem, the diameter of a bolt, the weight of a powder charge, the tensile strength of cotton yarn, the life span of a tire, the crushing strength of concrete, or any other desirable quality — is what a manufacturer tries to build into his product.

Specifications

Before production begins, the desired quality characteristics should be decided upon and then should be written into the specifications. The description of the article to be manufactured is in actuality the description of the *ideal* article desired, and it is the manufacturer's task to make his product as nearly identical to the ideal article as is practical and profitable.

Actually, of course, no manufactured article is *exactly* like the ideal article specified. One may wish to make a bolt 20 mm. in diameter, but, no matter how much care goes into its manufacture, the actual diameter is never *exactly* 20 mm. In fact, in spite of all that one can do, no two manufactured bolts selected at random ever have exactly the same diameter.

Here is a fundamental truth that must constantly be kept in mind. No matter what the desired characteristic of the article which one is trying to manufacture, it is inevitable that this characteristic will vary from article to article. There is always a certain amount of variation present, be it little or great. The fact that no two articles can ever be made exactly alike is inescapable, and one is forced to be content to make them as nearly alike as possible.

Variation

Obtaining manufactured articles of good quality, then, simply means that variation in the quality characteristic desired is being held within certain acceptable limits.

With this idea of quality thoroughly in mind, it is not difficult to agree on what "control of quality" should mean — that the amount of variation in the desired characteristic is to be held within as narrow limits as is practical or economical.

The fundamental ideas expressed thus far are so important that they can profitably be restated briefly. Inherent in every manufacturing process is a certain amount of variation. The amount of this variation depends upon the process itself, and it is the control of this variation that determines the quality of the finished product.

Two kinds or types of variation are found in manufacturing processes: *random variation* and the *variation due to assignable causes.*

To the statistician, random variation means that the process is operating under *a constant system of chance causes.* Stated more simply, random variation may ful to the manufacturer—random variation which can be regarded as usual or normal for a process when that process is doing the best that it can. Stated a third way — one perhaps more meaningful to the manufacturer-random variation is caused by so many and varied factors that it would be futile or uneconomical to attempt to find them.

Variability due to assignable causes means exactly what it says. There is present a cause of variation that can be sought for profitably and, when found, can be economically removed. Obviously, this latter type of variation can be controlled, and, just as obviously, the former cannot. Therefore in any instance the question always arises: "Does the process as it is now operating contain both types of variation"?

Use of Statistics

It is precisely at this point that the science of statistics enters the picture. It is the tool that differentiates between the two types of variation and it tells one when the cause of variation can be found and eliminated and when to let the process alone because it is doing the best that it can.

Statistical control of variation, therefore, deals with a quantitative measure of variability. It tells when the variation is large enough for a profitable search to remove the cause, or when it is small enough to let it alone. Statistical quality control gives one an objective rather than a subjective judgment of the variation that can be regarded as usual for any given process.

It is this fact that gives statistical quality control much of its power and usefulness. By its aid, an inexperienced foreman can judge a manufacturing process as well as the foreman with years of past experience to call upon. In fact, it frequently happens that the use of statistical quality control surprises the older foreman by showing him that his past experiences are not always an infallible guide. One instance of this might be of interest.

During the war, an old, established firm converted its plant to the manufacture of many of the various parts that go into an airplane engine. The chief engineer was responsible for the control of quality in this plant, and hearing of

statistical quality control, he availed himself of the first opportunity to take a course in which the subject was taught.

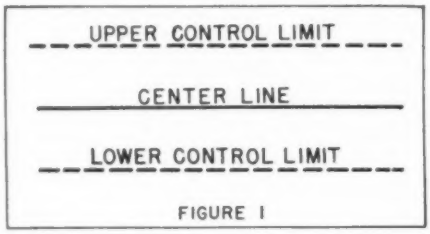

FIGURE 1

Returning to his plant, he thought of several processes that he knew were not operating at their best and hoped that his new knowledge would help him to locate and eliminate the troubles. However, his training in statistical quality control had not been very intensive, and he did not feel that he knew enough about it to apply it to a process in which he knew there was trouble. As a start, and in order to gain experience with statistical quality control, he decided to apply its principles to a process that had never given him any trouble. It was true that the process was turning out some unacceptable pieces, but the scrap amounted to only five per cent of total production, and he knew that the output of all other firms manufacturing this same item was running as high as eight and ten per cent scrap. In addition, his previous experiences in making such items told him that it was unusually good to have only five per cent of the items fall outside the close tolerances allowed. In short, experience told him his process was doing the best it could and that it needed no further attention.

Applying the analysis of statistical quality control to this process, he was amazed to find in actulity the process was not doing the best that it could. Upon investigation, he found that the parts in question were being made on four automatic machines and that an endless belt brought the finished articles to an inspection table where each was examined and the five per cent not conforming to specifications were discarded. By inspecting the output of each of the machines separately, he found that all the bad pieces were being turned out on one machine. This machine was immediately taken out of production and dismantled. A defective part was found, and, when it was replaced, the machine no longer produced articles that did not meet the specifications.

The above illustration is typical. As long as the judgment of a given process is subjective rather than obpective, there is always the danger of deciding that the observed variation in quality is random, when in reality it contains variation due to assignable causes.

Control Charts

To determine objectively the type of variation that is occurring in any given manufacturing process is relatively simple. This is done by constructing what is known as a "Shewhart control chart," To construct such a chart, one carefully examines a number of products of the manufacturing process under observation. A few simple statistical calculations are then made, and the chart is drawn, usually taking the form shown in Figure 1.

The solid line down the center is known as the *Center Line* and represents the average quality of the characteristic being manufactured. The dotted lines appearing on either side of the central line are called *Control Limits* and represent the extreme limits to be expected in the manufactured characteristic if the process is doing the best it is capable of doing. After the lines are drawn on the chart, the actual results of the manufacturing process are plotted as points. Each point usually represents the average quality observed in five selected samples.

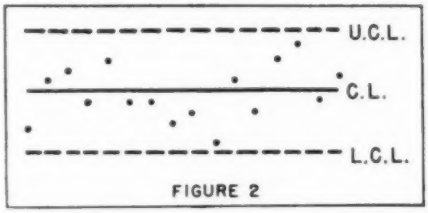

FIGURE 2

If all the points represents actual production fall within the dotted line, as shown in Figure 2, the process is said to be under *statistical control*. This means that the variation in quality is completely random, or that the process is operating under a constant system of chance causes. No amount of minor adjustment or tinkering with the process will affect the quality of the product; in short, the process is operating at its best.

If, however, some points fall outside of the control limits, as is the case in Figure 3, the process is said to be out of statistical control and is not turning out products of as good a quality as it is capable of manufacturing, meaning that there are one or more assignable causes of variation present. To one familiar with the manufacturing process, it is usually a relatively simple matter to search for and to find these assignable causes of variation. Once the cause of variation is discovered, it can then be eliminated, with resultant improvement of the product. If all such assignable causes of variation are removed, then all the points representing future production will fall within the dotted control lines.

It is well to point out here that the control limits — the dotted lines that differentate a process that is doing the best it can from a process that is not — are not placed on the chart arbitrarily, nor are they the results of some individual's opinion. These dotted lines are determined by the process itself. It is as if one went to the manufacturing process and asked it, "What kind of work are you capable of doing?"

"The dotted lines," would be the answer. The process in effect says, "This is what I am capable of doing. When I am operating at my best, all my production will fall between these two dotted lines."

As long as a manufacturing process is out of statistical control, there is no way of predicting what the quality of any future production will be. There is only one way to assure quality from such a process; it is necessary to inspect each and every article manufactured in order to discover and to discard those whose quality characteristics fall outside the acceptable limits.

On the other hand, if a manufacturing process is under statistical control, as illustrated in Figure 2, then one can safely assume that all future production will fall within the control limits. In such a case, all that is necessary for one to do to assure the quality of future production is to take a sample from the process at convenient intervals to see that the process is remaining in control.

It is this statistical fact that has been of so much value to manufacturers using statistical quality control. Once their manufacturing process has been brought under statistical control, inspection is reduced to a very small fraction of what it was before statistical control was established. In many instances, this has resulted in a tremendous saving, since the manufacturer's cost of inspection has been greatly reduced while at the same time the quality of his finished product has been assured.

Specification Limits

After a manufacturing process has been brought under statistical control, two other lines representing the *specification limits* can profitably be placed on the control chart for individual items. If it should happen that the specification limits fall outside the control limits, as illustrated in Figure 4, the manufacturer can rest assured that all of his production will meet specifications, and he

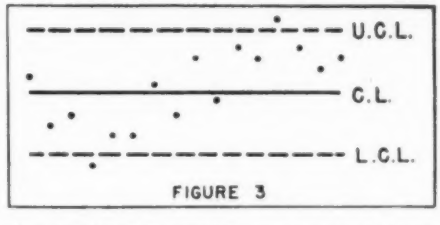

FIGURE 3

(Continued on page 17)

Book Reviews

MANAGERIAL ENTERPRISE

by Oswald Knauth
W. W. Norton, 1948

Reviewed by Professor Robert T. Livingston, Head, Department of Industrial Engineering and Management, Columbia University

This is an interesting and perhaps important book. Important not so much for what he actually proves — as the text does not prove the theory — as for what it suggests. The theory is that here in America we have developed a new economic system that differs so much from "free enterprise" on the one hand, or monopoly on the other, that the theories evolved from attempting to adapt them are not very revealing.

Having in effect stated this, he spends most of the book in a description of the "new" system. The description is not very convincing as most of the things he describes seem to be but logical derivatives — this of course does not destroy his theory but he does not anywhere categorically set up his points.

Toward the end he poses some questions and problems which must be solved but these are not very coherent or well organized.

Mr. Knauth feels that the title "free enterprise" is no longer valid and that what we have is a system of managerial enterprise. To start, this is somewhat like Burnham's concept. It is of course true that, in the development of the modern large corporation, the owner no longer occupies the position that he previously did. The owner is no longer the manager and the manager while, of course, owing a debt to ownership is no longer under the complete dictation of ownership that he used to be. This has bad as well as good points. The question naturally arises as to whether management under no direct compulsion and only concerned with retention of its own position will be wiser or more competent than under other stimuli. All of this leads rather obviously to the field of government management. Just what is the difference?

Mr. Knauth seems to feel that the stimulus is a continuation of authority and one must naturally ask whether that is good or bad.

He stresses:

(a) the increased size and specialization of capital equipment
(b) its value can only be extracted over a relatively long period of time
(c) long time continuity of the association
(d) the necessity for long time planning
(e) tendency to "control" from raw material to consumer

He says that in a "free enterprise" system costs can be estimated with a relatively high degree of accuracy and the assumption follows that they cannot in a "managerial enterprise" system, largely because of the problem of "allocation' which involves assumption.

Our present system, that Knauth calls "managerial enterprise" does not fit into the logical pattern of monopolistic competition derived from the theory of monopoly or from the concept of imperfect competition which is derived from the theory of free enterprise.

Competition has its strange aspects. While Macy and Gimbels are rivals yet either would suffer if the other went out of business.

The theories of free enterprise and the theories of monopoly have little to offer in the solution of this problem.

He poses certain questions which he says must be answered:

1. Is competition desirable and if so, to what extent? Is it socially possible to permit large units to be ruined?
2. To what extent can production be controlled to coincide with consumption — thus reduce boom and bust tendencies?
3. How about size?
4. How should management be selected and how controlled?
5. Are government corporations such as the T.V.A. desirable as yardsticks or should government actually subsidize competition?

This book is well worth reading but it is doubtful if it will help solve any problems.

THE SCIENTIFIC APPRAISAL OF MANAGEMENT

by Jackson Martindell
Harper and Bros.; N. Y., 1950 — 278 pages and appendix

Reviewed by Robert Teviot Livingston, Professor of Industrial Engineering and Management, Columbia University.

Mr. Jackson Martindell, President of the American Institute of Management has written an interesting book which distills his long professional experience into fourteen chapters starting with a definition of the general problem and successively proceeding through many of the important areas and aspects of management ending with a summary which he calls "The Principles of Excellent Management." Except for the lack of references and citations, this book could well serve as a text for a valuable graduate course in a Department of Industrial Engineering.

The title is unfortunately misleading. One expects that a method will be submitted by which the management of an enterprise can be objectively measured and evaluated. While an excellent appendix presents "Management Audit Material" and the appendix is labelled "The Objective Method of Management Audit", the scoring system submitted is entirely arbitrary and the method of determining the score completely subjective. Similarly, throughout the book, few if any actual "measures of management" are submitted; certainly none that can actually be quantisized and this in spite of the challenging statement on Page VIII of the Preface:

> ". . . the problem . . . is . . . one of devising means whereby the special qualities of individual managements can be measured"

If this is the problem, and it is, then the author never really faces it. Occasionally he approaches it and in his final chapter he makes some summary generalizations but he never comes out and says "This management is better than that management *because* . . . ."

Part of the faults lies in the adherence to the now outmoded case system and his refusal to generalize. However, the cases used are excellent, usually two differing considerably are presented and the reader cannot help but draw many conclusions from the material submitted, in spite of the absence of the author's conclusions.

The problem considered is definitely *Top Management* and the accent is on major decisions and how they are arrived at. Each case is presented clearly and the matters which must have influenced the decision and the possible results of alternative decisions are presented. This method and the covering explanations and generalizations draw the reader into the problem so that he gets the feeling of understanding and actually participating in the decision. It is this that lends an air of reality which is so lacking in most books on the subject. The chapter on research is excellent, this alone making the book worth-while reading.

Perhaps one of the most interesting aspects of the book is the challenge to management which is presented. According to the author, the decrease of production per worker and the rising cost of production is not blamed upon the worker, or upon the "decay of the social system," or the unreasonable demands of organized labor but squarely where it belongs on uninspired and incompetent management. In a word, it is "stupidity" not "cupidity" which is to blame. Ownership, due to its increasing diffusion has little influence, directors are generally too old, too conservative and too uninterested in the real problems of the companies. Who then is to be blamed and who must grow up? It is obvious: Management!

STATISTICAL QUALITY CONTROL

(Continued from page 15)

may stop all inspection except for an occasional check to see that the process is remaining in statistical control.

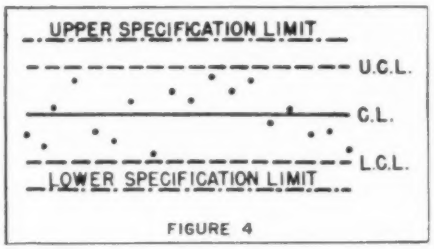

FIGURE 4

Should the specification limits fall within the control limits, as illustrated in Figure 5, this presents altogether another problem. First, one must remember that the process is under statistical control, so that, even though it is doing the best it can, there will inevitably be points falling outside the specification limits, since points may fall anywhere within the control limits for a process that is in statistical control. In such a case, a point outside specification limits,

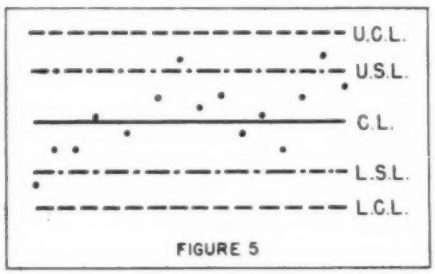

FIGURE 5

although it is within control limits, represents characteristics of unacceptable quality. Therefore although the process is under control, some scrap will inevitably be manufactured. As has been stated before, no amount of adjusting or tinkering with the process will improve the situation. Nothing short of a major change in the process such as new machines, new methods, new materials, or different operators will bring the control limits closer to the central line. If the specification limits cannot be widened, either the process must be completely changed or the unacceptable quality items must be screened by 100 per cent inspection.

Manufacturers who have been using statistical control state that, in many such instances, a conference between the manufacturer and the user of the product has often resulted in a relaxing of the specification limits. When all parties concerned are familiar with the assurance in quality that is given by a process that is under statistical control, they usually find they do not need the protection of extremely tight specification limits.

Who Can Apply the Method?

Many manufacturers, hearing of statistical control, would like to try it but are frightened by the word "statistical." They fear the need of a highly trained statistician to do the job. Actually, such is not the case. In fact, it is much better to take a person already familiar with the manufacturing process and then teach him how to use statistical quality control. It has been aptly and accurately stated that statistical quality control is less than five per cent statistics and over 95 per cent engineering or technical knowledge of the process under consideration.

Any person with as much as high school training in algebra and arithmetic can make the calculations necessary to draw the control chart and place the production points on it. In most plants, relatively low-salaried clerks do this part of the work. Once the charts are prepared, they are studied by the chief inspector or production engineer, or whoever is in charge of quality control. If the person in charge has had sufficient training in the control of quality through statistical methods, he is then able to interpret the charts and to take whatever action they indicate to be necessary.

During the war years, statistical quality control was taught to chief inspectors and engineers from war plants in ten-day intensive courses. It was found by experience that a person familiar with a manufacturing process could be taught enough statistical quality control in ten 8-hour days to enable him to start using the process successfully in his own plant.

These ten-day wartime courses were taught under the auspices of the Office of Production Research and Development. Since the close of the war, several schools scattered throughout the United States have continued to offer ten-day intensive courses in statistical quality control, once or twice a year. The tuition charge, which includes all the necessary books and materials, is usually around $100. More and more manufacturing plants are learning that it is highly profitable to meet the cost of training their personnel in this new method of controlling quality. In most instances, the first application of statistical quality control results in a saving to the manufacturer that more than meets the entire cost of the course.

The use of statistical quality control, then, simply adds a few easily employed statistical tools to the store of knowledge already possessed by the men responsible for the control of quality of manufactured articles. These tools, however, enable a quality control department to bring to bear on its tasks the powerful theorems long used by the statistician.

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Have You Seen This?

Recording Gage Posts Its Own Quality Control Chart

Realizing that the recording of measurements and the application of statistical quality control would be greatly facilitated by incorporating the control chart in the inspection instrument, Federal Products Corporation developed the illustrated Model 500 Recording Gage. This device saves considerable time for the inspector since it automatically posts

its own chart. Also human errors in reading the gage and recording the measurements are eliminated.

PNEUMATIC REVERSIBLE SCREWDRIVER

Scarcely larger than a fountain pen, the Cleco A-1 Screwdriver is especially designed to speed production jobs that require driving many small screws and other fasteners up to the equivalent of No. 8 machine screws.

Small size, light weight and freedom from torque reaction combine to make the Cleco A-1 exceptionally easy to handle. Operator fatigue is reduced, making possible continued high production with minimum spoilage of work and markedly reduced overall costs.

The balanced impact mechanism absorbs the driving torque, permitting finger-tip operation and control. There is no possibility of the tool twisting in the operator's hand or jumping out of the screw slot.

The Cleco A-1 Screwdriver is extremely economical in air consumption during operation. Also, since the throttle valve is opened by pressure on the bit, wasteful "free running" is eliminated.

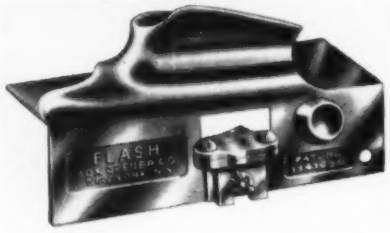
Rotation is easily reversed — making it possible to remove screws rapidly. External adjustments for power and reversing make disassembly of the tool for adjusting unnecessary.

Length, 5-7/16"; Maximum Diameter, 21/32"; Weight, 9-1/2 ounces; Capacity, No. 8 Machine Screws or equivalent.

The Cleco A-1 Pneumatic Reversible Screwdriver is manufactured by the Cleco Division of the Reed Roller Bit Company, P.O. Box 2119, Houston 1, Texas.

Flash Box Opener

Flash Box Opener Co., Inc., 52 West Houston Street, New York 12, N. Y., announces an improved Flash Opener. It is the only carton opener with the exclusive patented blade holder that is speedily adjusted to cut varying thicknesses of carton covers. This amazingly new and patented box opener opens any carton quicker and cleaner. The Flash Box Opener protects contents of cartons because it penetrates exactly under the outer cover thickness. It cuts cleanly, permitting reuse. Flash Box Opener pro-



tects the user from injury. The Flash Box Opener is made of durable zinc.

NEW CARDINEER FILE ROTATES HORIZONTALLY

No "in the hat" record-keeping system is this new Cardineer Horizontal Rotary File. It brings orderly record-keeping where activity is high and an inefficient system would waste time and money.

As a rotary file, it's unusual in that it revolves in a horizontal, instead of a vertical, plane. Thus, all the records are in a natural position for posting or reference without removing them from the rotor.

This compact unit well serves the requirement where breaking down of large concentrations of records into small work-units gains the advantage of a high degree of control and accessibility. Where there is a large amount of casual reference by persons other than the regular operator, this breakdown of records allows several persons to us them free of interference with each other — saving the time that would be lost otherwise.

Each file holds up to 2,700 records in a convenient working position — no containers to open; no drawers to pull out. A natural, wide-open working "V" makes it easy to post to the records in their normal position on the rotor. All the advantages of Cardineer Rotary Filing — better control of motion, space, time, and economy — are now offered for smaller installations through this horizontal Cardineer.

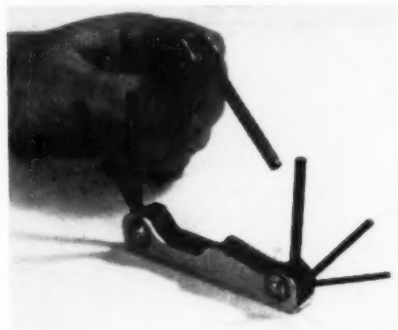
No adjustment is necessary when adding or removing a record — records are added or removed in one motion at any place in the file.

Records are housed on three removable trays, allowing distribution of record-keeping work. These trays are self-supporting when off the rotor.

Records in a large variety of sizes up to 8 x 8, or 9 x 5½ inches, can be accommodated on this all-steel file. This new addition to the Cardineer line is manufactured by Diebold, Inc., Canton 2, Ohio.

5-In-1 Socket Wrench Set Saves Time

Eliminate the element "find socket wrench" by putting Smitty, the compact 5 unit socket wrench set, in the pockets of the maintenance men. Write to R. N.



Hunter Sales Co., Los Angeles 23, Calif. for details.

VOICE COMMANDS OPERATE BI-LINGUAL ELEVATOR

A bi-lingual elevator was demonstrated to conferees of the recently held Building Owners and Managers Association convention in Montreal, Quebec, Canada — the French and English speaking city.

The elevator operator didn't pull a handle, or push a button, or even touch a button. But when he called out "going up" or "monter" into a microphone, the elevator doors closed immediately and the car rose to its destination. He

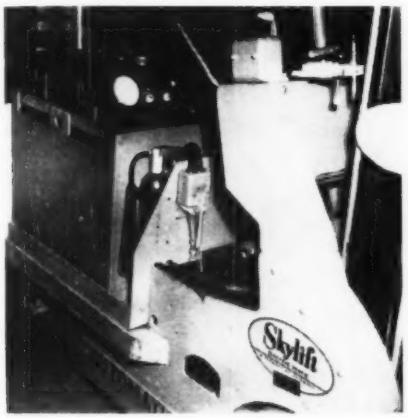
called out "down please" or "descendre" and the car returned to its starting position.

The elevator car was a model, one foot high, that responds to voice commands — in English or French.

The bi-lingual elevator travelled up and down between three "floors" in a ten-foot-high model hoistway. The passenger cab and hoistway were complete with working miniatures of all the standard equipment found in elevator installations — safety, speed governor, counterweight, oil buffers, guide shoes and guide rails.

Two-way Radio — The Latest Handling Aid

Two-way radio sets on fork trucks are the latest wrinkle devised by materials handling engineers to cut costs. Wasted



time and traveling without loads are slashed by up-to-date communications. Photo shows a Skylift electric truck, made by the Automatic Transportation Company, Chicago, equipped with a Motorola two-way short wave set. A fleet of seven Skylift trucks have been equipped this way at the Johnson & Johnson shipping center, Metuchen, N. J.

SIMPLIFIED PACKAGE HANDLING

The "Beacon Claw" simplifies box and package handling, is extremely lightweight yet has a capacity of 500 pounds to 1000 pounds. The grab exerts its own pressure, the heavier the load the tighter it holds. Heat treated spurs in the jaws are easily replaced, and narrow jaws allow for close stacking. Other jaws are lined with non-slip material for handling cartons. Handling of boxes and cartons is expedited because of the ease with which it operates. Operation involves merely setting it over a box and lifting.

The grab is made in three standard sizes: 4″ to 10″, 10″ to 20″, and 20″ to 30″. Variations of these sizes as well as a variety of jaw designs may be obtained. For further details, write to Cleveland Beacon Products Co., 1480 Lakeside Ave., Cleveland 14, Ohio.

AUTOMATIC TIME

By WILSON J. BENTLEY

A DEVICE for automatically recording time elements has been designed by Mr. H. G. Thuesen, Professor of Industrial Engineering and Head of the School of Industrial Engineering at Oklahoma A. & M. College. This Time Recorder was constructed in the Oklahoma A. & M. College Engineer Experiment Station and is now being used by the School of Industrial Engineering in connection with Time Study Research, Training, and other similar activities.

In ordinary practice, time study readings are taken with a decimal timer which records to 1/100 of a minute. In using a decimal stop watch, the time study observer must record the action taking place, note the watch reading at the end of an element, and then record the time noted. This common practice necessitates the shifting of the observer's attention from the work being observed to his watch, and then, to the time study observation sheet. For short cycles of time, as encountered in time and motion study research, the accuracy of the observer in noting and recording the elemental times leaves much to be desired. Designers have sought to overcome the short comings of the decimal stop watch by employing a Kymograph in which electrically controlled scribers record on a moving tape. Since a linear distance on a tape in this device is a measure of elapsed time, it becomes necessary to make linear measurements of the distances between records made by these scribers. It can be readily seen that the work of reading the distances on the tape becomes a limiting factor in making an extensive research or when time values are needed immediately after they have been recorded.

This timing device which Professor Thuesen has designed records the time of the occurrence of an event to 1/1000 of a minute directly in numbers placed in order of their occurrence on a roll of paper. The device is manually operated to the extent that the operator must depress a small lever at the instant a recording is desired. By this action the time is recorded on the roll of paper. The Time Recorder has guides which enable the observer to write in symbols and words the description of the time reading. Thus the subject may be observed even when readings are being made and recorded. The device actually has three spaces which the observer may use. These spaces are placed so that he may record the description either previous, during, or after the recording of the time.

To describe the Automatic Time Recorder more specifically, it can be said that the elements of time are obtained by driving two print wheels with a synchronous induction motor. These wheels are graduated from 00 to 99 around the circumference and are geared so that they record to the nearest 1/1000 minute. When a recording of an element of time is desired, a lever is operated with the thumb, or index finger, which causes three synchronized movements to take place. First, a continuous strip of paper is advanced to a new position and stopped. Second, a hammer surrounded by an inked ribbon falls on the paper directly over the print wheel recording the time at the instant. Third, at the end of the travel, the inked ribbon advances to a new position. Releasing the actuating lever causes the mechanism to adjust itself for the next recording. The result is a continuous strip of paper being reeled upon a removable spool bearing time recordings in minutes, tenths, hundredths, and thousandths of a minute together with identifying marks and symbols inserted by the operator beside each recording.

The recorder is light in weight and easily portable. It has a 15 foot electrical cord which allows the recorder to be used under most shop and plant conditions. The experience of Professor Theusen and members of his staff with the Time Recorder indicates that it will prove to be an efficient means for research and training in time study. Experimentation further indicates that the use of this device can be a valuable aid in both educational and industrial organizations where accurate time measurement is essential.

The automatic time recorder serves a need between that served by decimal timers and a more complex device designed by Professor Thuesen for the University of Iowa. The later device automatically records 12 elements to 1/10,000 of a minute. This timer was built by The University of Iowa and The Western Electric Company for research in motion economy.

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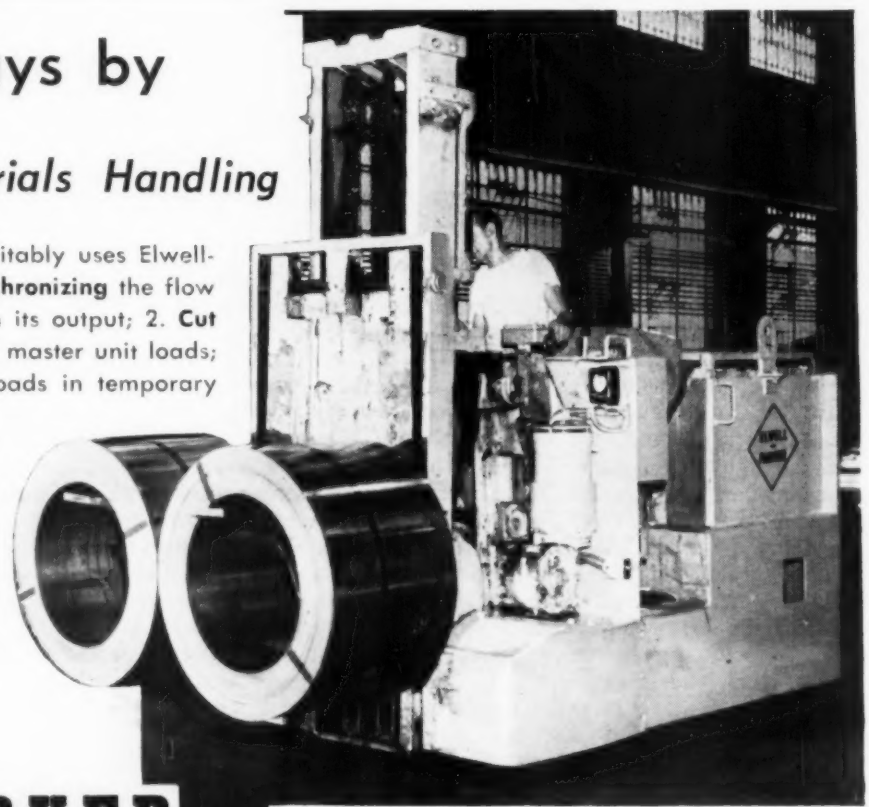

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